

UNCLASSIFIED

**Defense Technical Information Center
Compilation Part Notice**

ADP013412

TITLE: Liquified, Toxic and Corrosive Gases in Hae'Vily Populated Areas

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: Chemical and Biological Medical Treatment Symposium - Industry
II World Congress on Chemical and Biological Terrorism

To order the complete compilation report, use: ADA411272

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:

ADP013371 thru ADP013468

UNCLASSIFIED

42. LIQUIFIED, TOXIC AND CORROSIVE GASES IN HEAVILY POPULATED AREAS

Franjo Plavšić, Alka Čoporda, Zdravko Lovrić Croatian National Institute of Toxicology
10000 Zagreb, Martićeva 63a, Croatia

INTRODUCTION

Harmonization of the Croatian legislative with European directives on hazardous substances, and adoption of various international agreements and conventions such as APPEL program and Convention on Prevention of Transborder Transfer of Accident Sequences, have opened numerous problems related to the present situation with hazardous chemicals. One of such problems are risk facilities used for storage or use of gaseous toxins in densely populated areas. This presentation is limited to only two chemicals, chlorine and ammonia, as these are frequently found at high-risk sites. It is estimated that in Croatia, these two chemicals are found at more than 250 locations in amounts potentially risky for the population living close to the sites of their storage or usage.

The problem is not only where the chemicals are found, but even more it is associated with the accident preventing measures, which as a rule are still quite inappropriate. In the Republic of Croatia, water disinfection is mostly done with chlorine, while ammonia is unavoidable in all large cooling systems (e.g., industry refrigeration plants and skating rinks). The facilities with chlorine and ammonia are generally located in densely populated areas of all Croatian cities, while the measures of accident prevention as a rule are quite poor.

METHODS AND RESULTS

The city of Zagreb with more than one million citizens is taken to exemplify the situation, emphasizing that the situation is identical in all other cities and towns in Croatia. At more than ten locations, chlorine is stored in amounts ranging from 150 kg to 2.5 t, while ammonia stores exceeding 5 t are found on at least ten locations. These data probably are not fully reliable, as these chemicals have occasionally been found at quite unexpected and poorly protected sites, sometimes even being forgotten. Two years ago, 300 kg of chlorine were detected in an old and abandoned pool for medical rehabilitation in a densely populated area of the city. In fact, it is difficult to find a site in the city of Zagreb, which has not been potentially endangered by either of the two chemicals in case of an accident due to any reason. An act of sabotage should by no means be ruled out, as it may provide an extremely efficient and simple way of causing damage or endangering human health.

The situation in the very center of Zagreb, i.e. in the residential area of Šalata, with a large sports complex with swimming pools, skating rinks and other sports facilities, may be taken as an example. These storage facilities have been flimsily built with poor protective and accident-preventing systems, while protection from a potential terrorist attack does not exist at all (as it does not exist in any other similar facility in Zagreb either). The two chemicals, chlorine and ammonia, produce a vigorous and explosive interaction, while each of them is extremely life- and health threatening. The chlorine storage has two 1000-kg chlorine containers situated right above a crowded and densely populated area.

Accident simulation with complete destruction of one of the chlorine containers in the present conditions of total absence of efficient measures for disaster prevention or disaster consequence reduction was performed, taking into account unfavorable weather conditions with a most common northeast wind of 2 m/s. In a densely populated area within 250 m from the site of accident, the risk of life would begin 2 minutes from the accident and would last for at least 30 minutes, when atmosphere concentrations would decline below those causing

death on the spot in those found outdoors. An area within at least 600 m from the storage would be highly endangered. Due to the high chlorine concentrations in the atmosphere, lethal chlorine concentrations would be reached indoors within the chlorine contaminated area of 250 m in a few minutes.

This means that at least 10,000 people would be at high danger, and hospital capacities of the city of Zagreb would be inadequate to provide care for such a great number of patients suffering from, e.g., lung edema due to chlorine exposure. On the same location, similar situation is also found with ammonia, especially so as the amounts of ammonia stored are considerably greater (about 7 t) than those of chlorine, and because the molecular mass of ammonia is at least half that of chlorine, thus yielding much greater volumes of gaseous toxin.

Furthermore, in case of chlorine the risk would be limited to lower floors and to the unprotected people on the streets. In case of ammonia accident, those found in upper floors of residential and nonresidential buildings within a wide area from the site of accident would also be involved. Locations of similar risk level are also found in other parts of the city of Zagreb as well as in all other regions of Croatia.

For example, chlorine storage of 300 kg is located at about 150 m above the Učka tunnel entrance, with the wind blowing in such a direction that it would drive chlorine into the tunnel for 70% of the time during the year. Of course, before our intervention there was no plan of emergency action in case of an accident at the storage. Storages located at swimming pools highly frequented during summertime, poorly maintained and completely lacking any supervision have often been detected.

After all, the highest proportion of intoxication accidents has for years been recorded at swimming pools due to chlorine. On the other hand, it is petroleum products rather than chlorine that lead on our list of accident records.

DISCUSSIONS

Over the past year, in collaboration with sanitation department we embarked upon the study of risk locations with chlorine and ammonia storages, and attempted to set conditions for better accident prevention and regulations for procedures to reduce the consequences of such accidents. The following deficiencies were observed in a considerable number of such facilities:

- a) poorly educated personnel and complete lack of their training in the procedures to be taken in case of accident;
- b) lack of efficient plan of emergency intervention in case of accident or complete lack of any plan at all;
- c) in most cases, inappropriate instructions (procedures elaborated in writing) that actually pose more serious threat than their nonexistence;
- d) lack of a reliable burglary-proof system with alarm and telecommunication on increased storage concentrations of gaseous toxin;
- e) lack of a system for limitation of accident consequences, e.g., hazardous substance neutralizers or water curtain device;
- f) total lack of risk data in the local community, and especially on the procedures for health and life protection in case of accident; and
- g) other (e.g., poor maintenance of liquefied gas containers).

All these factors increase the risk of accidents involving hazardous substances, with potential risk for human health within a certain area from the respective storage. We

considered proper education on the protection from toxins to be the primary and most important action in the country as a whole. A very ambitious plan of education was launched, and has still been under way. Most of those employed in the chlorine or ammonia storing facilities were included in the program of obligatory special education.

They still remains the problem of continuous training, which will probably be better solved by the development of mandatory intervention plans for prevention of accidents and reduction of their consequences. Intervention plans have been regulated as mandatory company documents by at least two acts, one from the field of health care and another from the field of environmental control.

The Croatian Institute of Toxicology is an institution authorized for the development and evaluation of intervention plans in the field of health care, thus being in a position to insist on improvement of the measures for accident prevention. Clear and properly written procedures for all activities during the work, accident prevention, and intervention in case of accident, first aid and decontamination, communication with all services in charge of intervention, notification and population protection, medical procedures in care for casualties, etc., have a crucial role.

Unfortunately, in a great number of cases, those in charge of these issues in the companies involved consider the development of written procedures mere formality. We started to collect and file such instructions to be able to point to the most common mistakes during education. Most serious mistakes were found in the first aid and decontamination procedures, as they would imply a threat to the life and health of the injured. For example, mucosal neutralization with acids is as a rule recommended on exposure to alkali.

Typical instructions for the procedures to be taken upon exposure to gaseous ammonia via respiratory system state that breathing should be done through a piece of cloth soaked in acetic acid, with similar instructions for skin or eye decontamination upon acid or alkali spilling. Instructions for citizens on the procedures in case of accident with a gaseous chemical also are quite risky, especially when a decision on evacuation or confinement to airtight spaces is to be made.

We insist on mandatory simulation of the movement of a gaseous toxin cloud at most unfavorable weather conditions, which should be used as a basis to decide when and at what distance from the risk facilities particular population protective procedures should be performed. Of course, the population involved should be properly informed on the potential hazards in their neighborhood and on the modes of self-protection.

CONCLUSIONS

Besides education and clear procedures provided in writing, accident prevention includes many other factors. In addition to continuous and quality maintenance and service of the system, efficient prevention of uncontrolled entry in the facilities and telecommunication for all potential hazards such as attempted burglary or detection of gaseous toxin leakage within or outside the facilities are considered to be of utmost importance.

Development of neutralizers appears to be appropriate in case of usual liquefied gas evaporation on pipeline or valve accidents, however, various other possibilities should be anticipated for so-called worst cases when any neutralizer would turn inefficient. In such cases, responsible persons and services should be promptly notified, at the same time trying to buy some time and to prevent immediate release of all the amounts of liquefied gas, thus to be able to warn and protect the population on time.

We insist that each facility presents a specific case, and that all possible modes of delaying the development of the worst case should be carefully studied. For example, we have estimated that the best solution for the ammonia container at a skating rinks in Zagreb

would be the construction of a collecting basin under the ammonia container with hermetization of all outlets in the main engine-room of 1800 m³, except for one outlet on the building in front of which a device for preparation of a highly efficient water curtain should be mounted. In some other facility with another toxin, the situation would be different, pointing to a conclusion that each risk site should be approached individually on assessing the hazards and determining the measures for risk reduction.

Therefore, we presume that the initiated activities on the development of individual intervention plans for risk facilities in Croatia will take several years. However, most important of all is to change the awareness of those employed in risk facilities, and this issue should be paid most time and attention indeed.

KEYWORDS

Chlorine, ammonia, accidents, worst case